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(54) Releasable grip arrangement for an oil well

(57) The invention relates to an releasable grip arrangement which is to provide an impermeable barrier in an annular space between an inside tube and an outside tube of an oil well to maintain a differential pressure between one side of the releasable grip arrangement and the other in the longitudinal direction. The releasable grip arrangement or a part of it is made of a material which may be dissolved by a suitable solvent. The arrangement may include locking members 3, 4 which have engaging wedge surfaces so that the slip 3 can be expanded into engagement with casing and seal members 2, any part of which may be dissolved to release the arrangement. The arrangement can include a sleeve which comprises holes 51 which can be blocked during normal use but can be opened to permit the entrance of a solvent. The invention can be applied to a well packer, a liner hanger, or coil tubing connector.

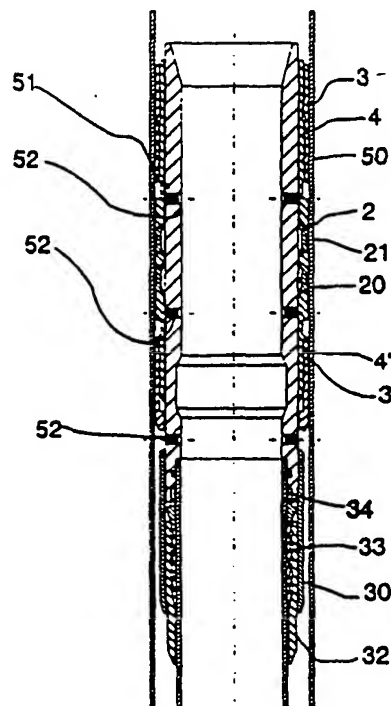


Fig 6

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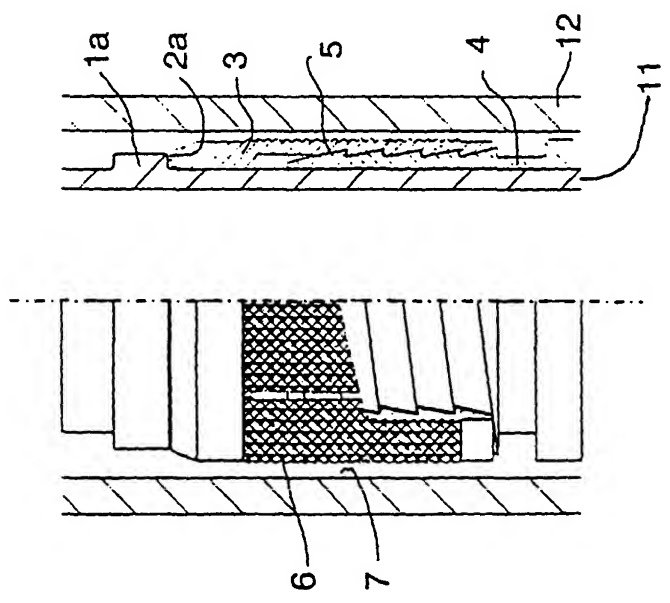


Fig 1

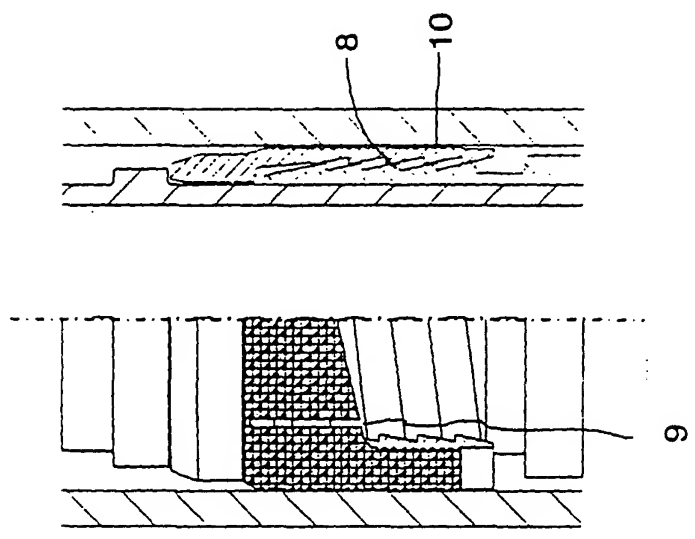


Fig 2

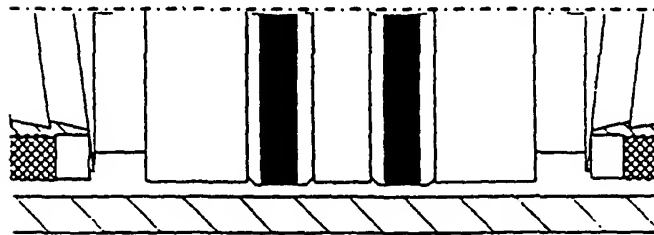
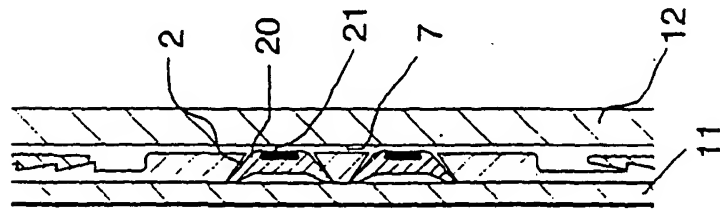
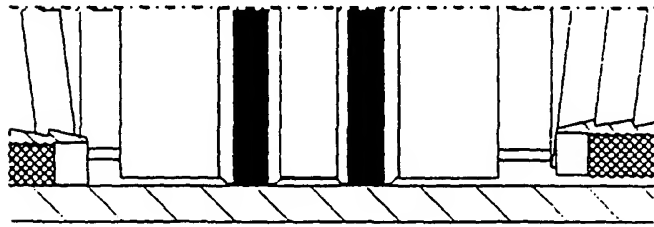
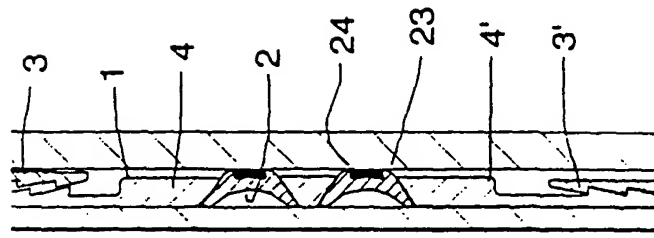


Fig 4

Fig 3

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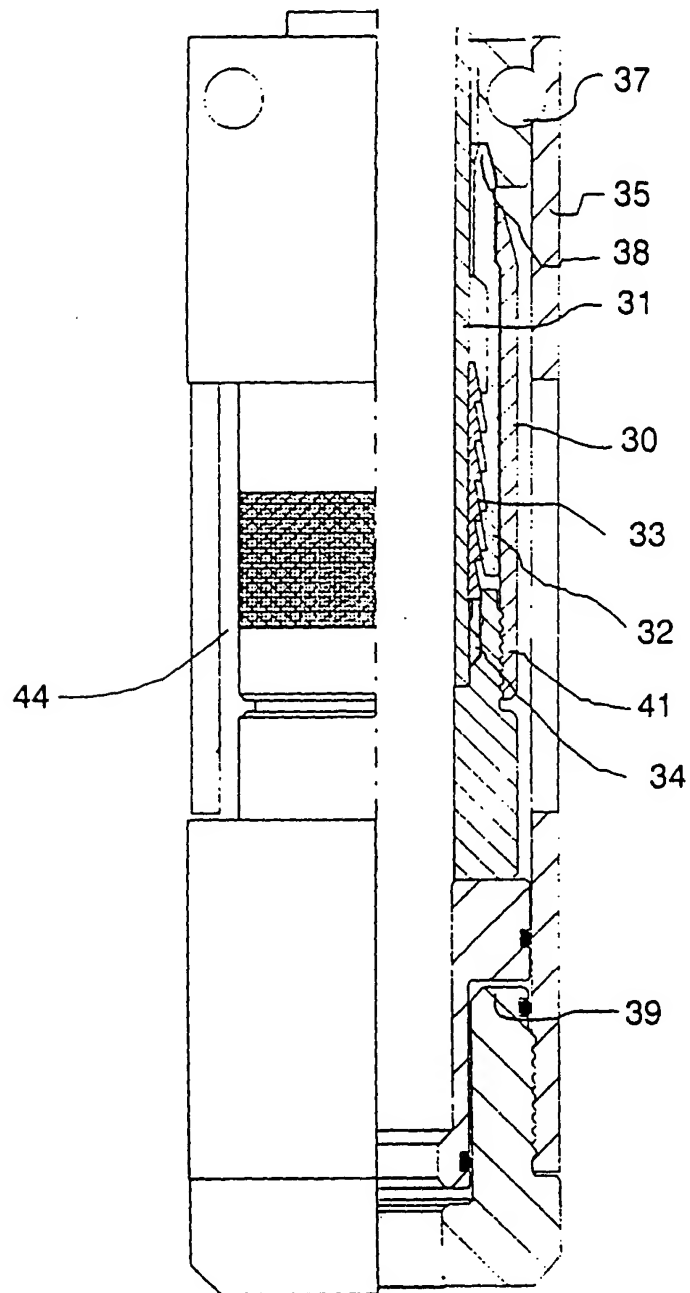


Fig 5

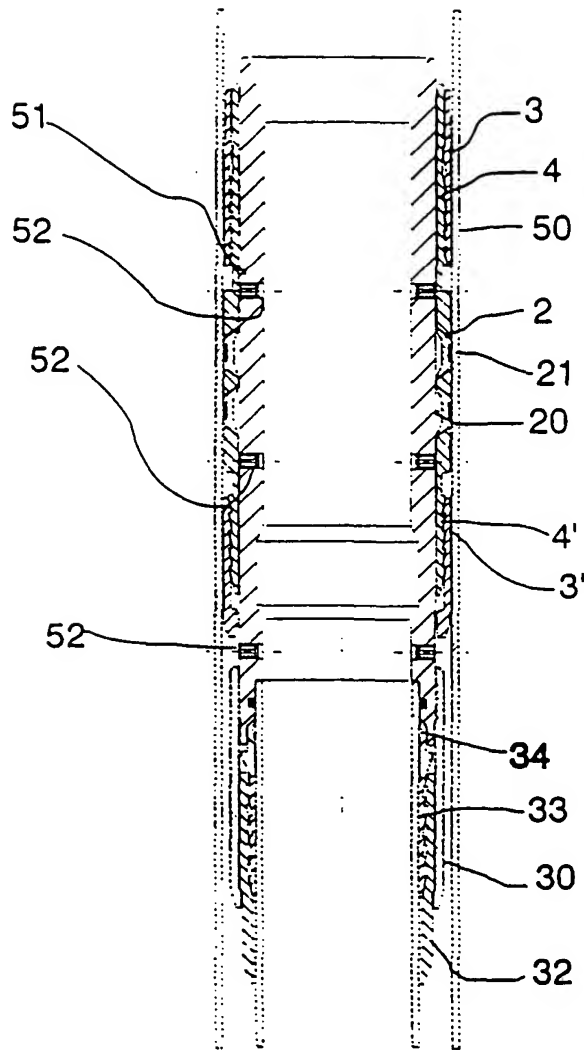


Fig 6

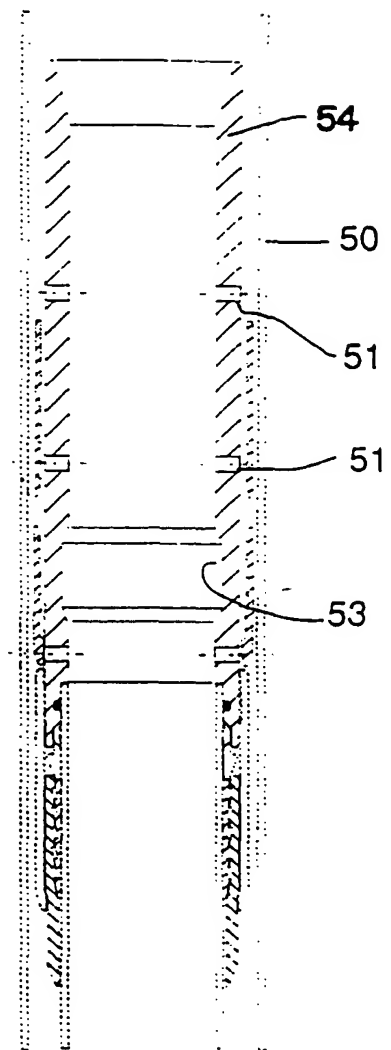


Fig 7

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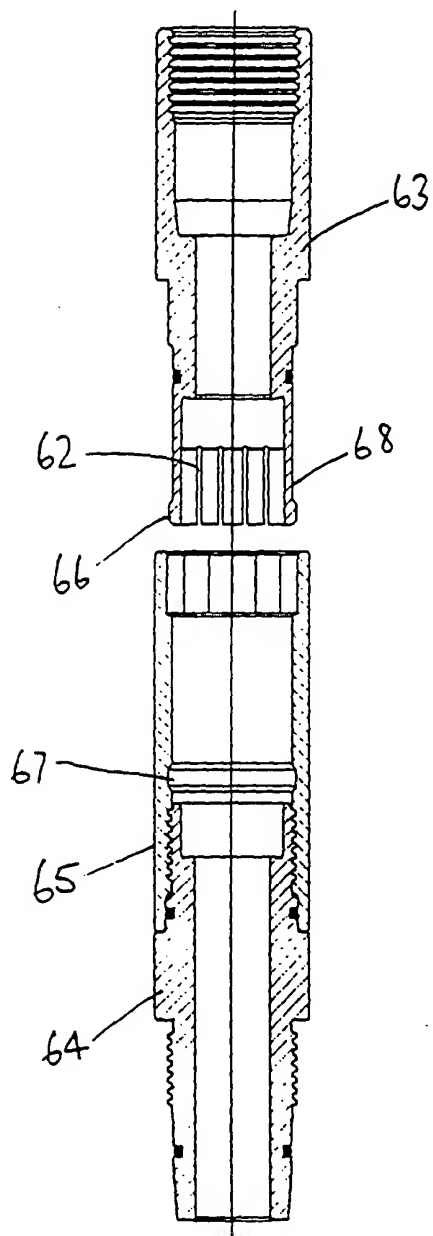


Fig 8

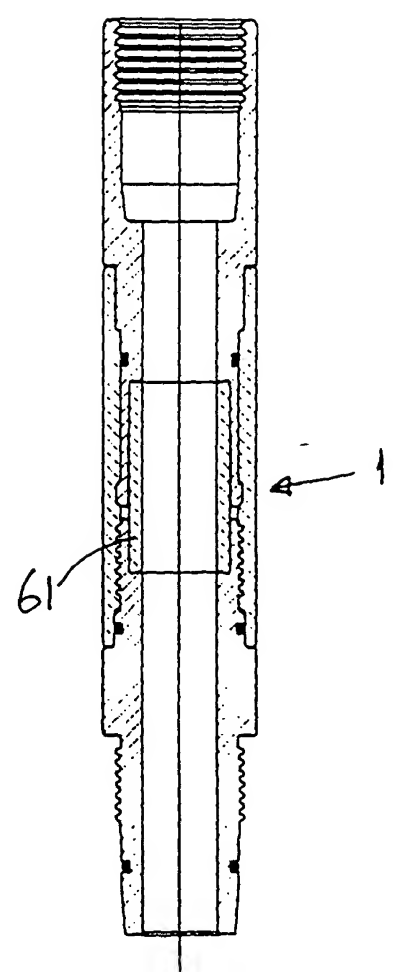


Fig 9

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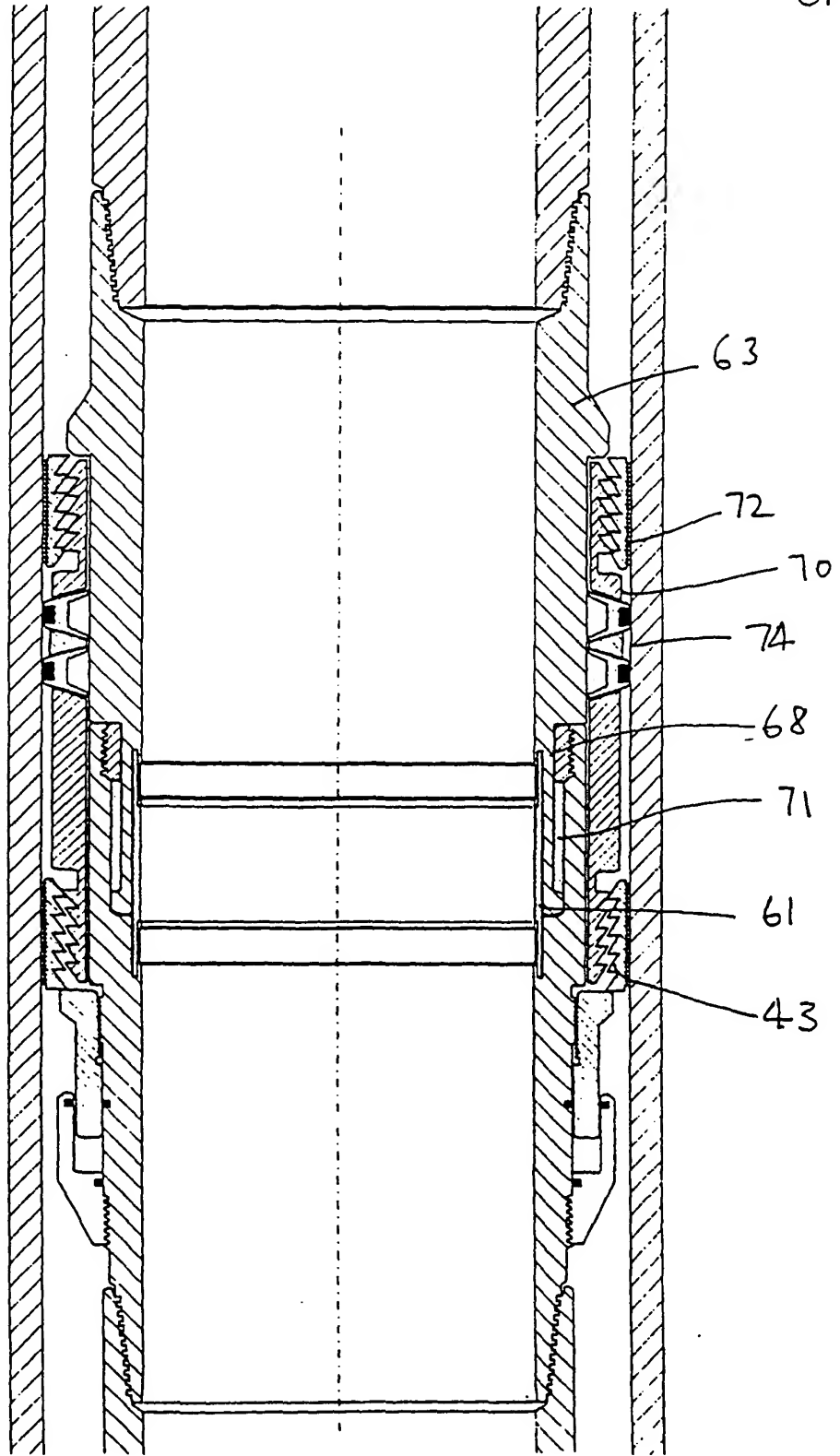


Fig 10

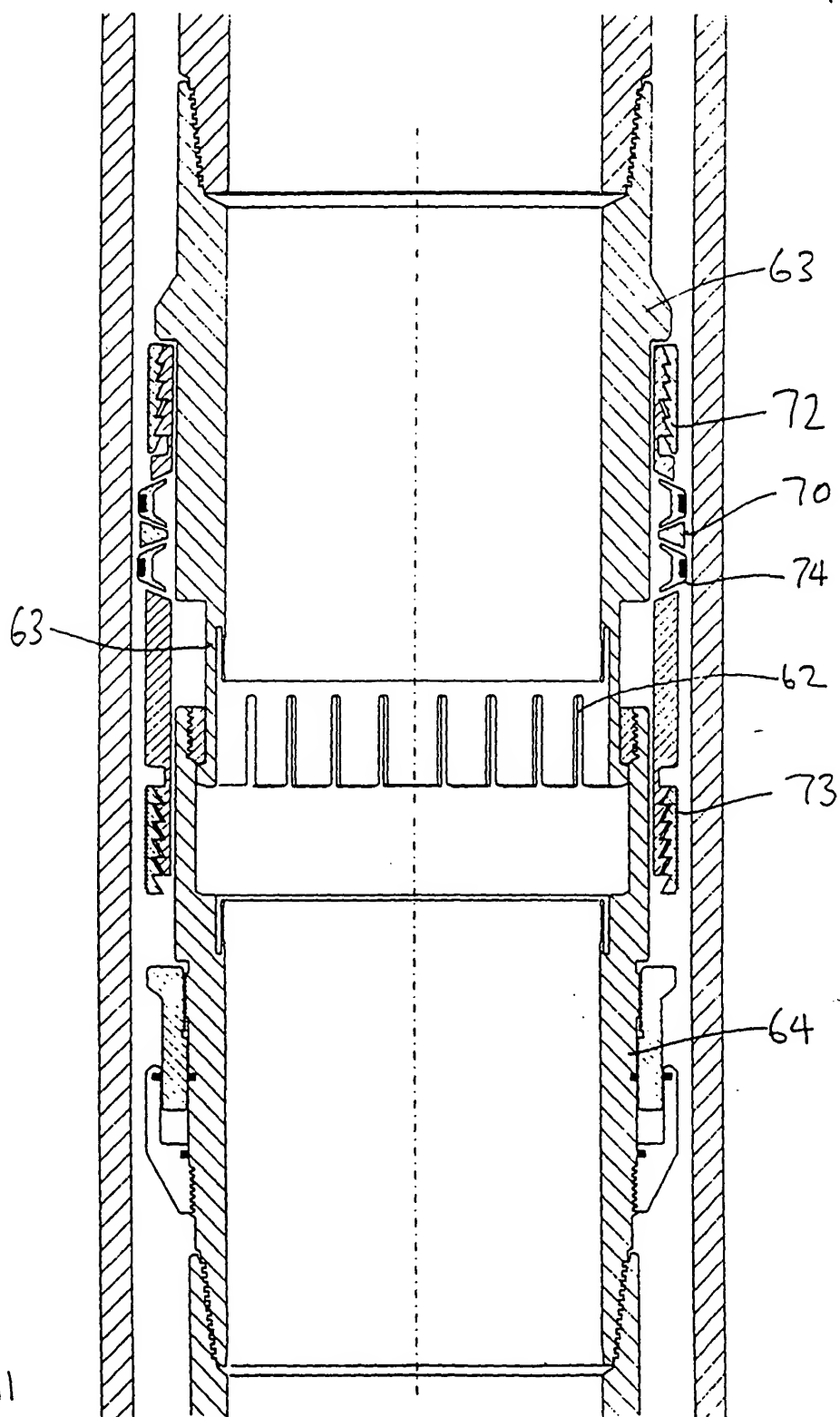


Fig. 11



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Dissolvable Grip or Seal Arrangement

The invention relates to a dissolvable grip or seal arrangement for packers, hangers, seals and coiled tubing connectors in oil and gas wells.

Packers or hangers are probably the most common element utilised in a subterranean well after the installation of the casing. Packers and hangers primarily form a pressure seal between the production tubes and the last casing set and cemented in the well. They can be subjected to significant differential pressure so require anchors to keep them fixed to the place they are required.

It has been conventional practice to use ratchet mechanisms to retain the packer or hanger in its engaged position, that is with the anchors, also known as slips, in the locked or "set" condition and the elastomer pressure seal in the sealing or "set" condition. Various methods can then be employed to deactivate the ratchet to retrieve the packer. They include rotating the assembly, over-pulling the assembly, releasing collets or machining it away. All these methods take up a lot of rig time and cause damage to the production tubes.

Furthermore with the advent of new wells being drilled into very hot formations conventional elastomer seals cannot endure long term exposure, deteriorate and can no longer form a pressure seal. Similarly, these wells can have extremely high pressure, which results in very high loads being exerted on the slip mechanisms.

Finally, there are new completions using coiled tubing. Until recently coiled tubing has mainly been used as work-over string for servicing oil and gas wells. Now, it has been employed in velocity strings, production strings and as spoolable gas lift strings.

It is envisaged that coiled tubing will become more widely used as the primary production path for future oil and gas wells. This is due to coiled tubing's improved quality, its ability for live work-over that it when the well is still producing and the economic savings.

However, coiled tubing has several limitations; namely, limited over-pull, ovality, connectability, the size and weight of storage reel requiring field attachable connectors, and current connectors use only 'O' ring seals. Current connectors either require the coiled tubing to be deformed or require large torque to be applied to ensure the grapple system grips.

According to the invention a releasable grip arrangement is provided, for use in an oil or gas well, which is to provide a gripping engagement between a first tubular section and a second tubular section telescopically arranged with respect to said first tubular section; the dissolvable grip arrangement comprising a first grip part and a second grip part which when engaged together form the required gripping engagement between said first tubular section and said second tubular section, wherein at least part of at least one of said first and second grip parts is made of a material which may be dissolved by a suitable solvent.

According to the invention there is provided an annular seal arrangement to provide a impermeable barrier between the annular space such as between an inside tube and an outside tube of an oil well, such that a differential pressure can be maintained between one side of the releasable grip arrangement and the other in the longitudinal direction wherein the annular seal arrangement or a part of it is made of a material which may be dissolved by a suitable solvent.

The annular seal arrangement may include at least one seal member and at least one locking member. The seal member or the locking member may be made from a material which is dissolvable by a solvent. The entire grip arrangement may be made from a material which is dissolvable by a solvent such as magnesium.

The releasable grip arrangement may include a sleeve which comprises holes which permit the access of the solvent to the seal member or the grip parts to dissolve said seal member or grip part or a part thereof.

Preferably the holes are normally covered up during normal use to prevent fluids entering the grip arrangement but may be opened when it is required to break the seal to permit the entrance of the solvent. The holes may be opened by means of a sliding member, alternatively the holes may be blocked by resilient caps which can be removed by a suitable mechanical levering action when the holes are required to be opened.

According to the invention the grip arrangement includes a release element which during the normal functioning of the seal ensures that

the seal arrangement is locked against the inside and outside tubes and yet which when dissolved by the solvent permits the release of the grip arrangement. The release element may be made out of titanium.

According to the invention the seal arrangement also comprises a seal support member which may be made from a material which is dissolvable by a solvent.

Preferably the grip arrangement includes a release element which, during the normal functioning of the grip arrangement in the engaged condition, ensures that the grip arrangement is locked against the first and second tubular sections and which when dissolved by the solvent permits the release of the grip arrangement.

Conveniently the first tubular section of the releasable grip arrangement comprises axially extending slots extending from one end and a protuberance extending radially outwards from said for engaging with a correspondingly shaped radial groove in the second tubular section such that when the first and second tubes are engaged telescopically together the protuberance engages in the groove. A sleeve may be provided arranged concentrically with and internally of the end of said first tubular section and preventing internal radial deformation of the end and thus preventing the axial separation of the first and second tubular sections.

A sleeve may be arranged concentrically with and externally of the end of said first tubular section made of a material which is dissolvable such that when the solvent is applied it passes through the slots of the end of the first tubular section and permits the

consequent release of the first and second tubular sections. Further grip parts or seal members may be provided externally of said second tubular section at least part of which are made of a material which is dissolvable by an appropriate solvent said solvent passing through the slots in the end of the first tubular means.

The sleeve is preferably made out of titanium.

Thus the invention permits easy disablement of the seal or packer which allows safe and easy removal of the coiled tubing from the well and avoids the other disadvantages of prior art systems referred to above.

An embodiment of the releasable grip arrangement according to the invention will now be described in the form of packer, hanger and connector assemblies, by way of example only, with reference to the following figures, in which :-

Figure 1. shows a longitudinal cross section of the locking members of the releasable grip arrangement of the invention not engaged.

Figure 2. shows a longitudinal cross section of the locking members of the releasable grip arrangement of the invention in the engaged condition.

Figure 3. shows a longitudinal cross section of the seal members of the releasable grip arrangement of the invention not engaged.

Figure 4. shows a longitudinal cross section of the seal members of the releasable grip arrangement of the invention in the engaged condition.

Figure 5. shows a longitudinal cross section of the hydraulic assembly tool used to engage the releasable grip arrangement of the invention.

Figure 6. shows a longitudinal section of an releasable grip arrangement according to the invention used as a tubing hanger engaged in a larger tubing or casing.

Figure 7. shows a similar view to figure 6. of the releasable grip arrangement after the application of a solvent,

Figure 8. shows a longitudinal section of a grip arrangement according to the invention for a connector,

Figure 9. shows the view of figure 8. with the connector in the connected position,

Figure 10. shows a longitudinal section of a grip arrangement according to the invention for a connector and seal arrangement,

Figure 11 shows the view of figure 9 in the disengaged position.

Referring to figure 1 an releasable grip arrangement 1 is shown which is to provide an impermeable barrier in an annular space between an inside tube and an outside tube of an oil well, to maintain a differential pressure between one side of the releasable grip arrangement 1 and the other in the longitudinal direction. The

releasable grip arrangement 1 or a part of it is made of a material which may be dissolved by a suitable solvent. Figure 1 shows the locking members 3, 4 which may themselves be made of a material which can be dissolved by a solvent. The releasable grip arrangement 1 comprises a main mandrel 1a which is the entire length of the seal arrangement 1 on which a shoulder surface 2a is machined. The seal arrangement comprises locking parts 3 and 4 which are screwed together on a very coarse ramp type thread 5. This ramp thread 5 is the method employed to deploy and engage the gripping surface 6 of the locking part 3 against the internal casing surface 7. During the engaging process the mandrel 1a is subjected to a strong downward force, and the locking part 4 subjected to a strong upward force. As the locking part 3 is pressed against the shoulder 2a the wider parts 8 of the ramped thread 5 outwardly displaces the gripping surface 6. Slots 9 cut into the locking part 3 allow this outward movement to take place. The gripping surface 6 comprises a very coarse knurled surface 10, so that when it contacts the casing surface 7 a great many individual indentations are formed making an ideal anchor yet not scoring the casing surface and causing potential corrosion spots.

Another feature of this seal arrangement is that because the locking parts 3 and 4 are screwed together the seal arrangement 1 can be of any desired length without effecting the internal bore on to which it is to be arranged. This allows the gripping force to be distributed over a larger surface area and hence reduces the unit area loading. The engaging force is uniformly applied along the entire length of the seal arrangement, because of the coarse thread 5. The gripping mechanism 10 forms individual indents providing superior torque resistance than conventions slips or grapples. The indents do not

score the surface they are gripping, and hence do not introduce stress risers or local corrosion points.

Referring to figures 3 and 4 the seal member 2 includes a seal support 20 and seal component 21. The seal support 20 may be made from a material which is dissolvable by a solvent.

Referring to figures 3 and 4 the metal-to-metal seal assembly will now be more fully described. The mandrel as described in figure 1 and 2 passes through this part of the assembly and is indicated. Figure 4 shows the upper locking members 3 and 4 engaged and lower locking members 3' and 4' not engaged, held in this position by shear pins not shown. Further downward force causes the shearing of these shear pins and the lower locking members are also forced into the engaged position thus securing the whole releasable grip arrangement in the engaged condition.

The metal-to-metal seal member 21 itself may utilise a composite construction consisting of a soft malleable alloy, dissolvable such as magnesium, which forms the pressure seal to the surface against which it is being forced 7. This may be backed-up by a strong alloy seal support 20 having a high modulus of elasticity.

In operation, when the high strength alloy seal support 22 is deformed 22, it contacts the casing surface at two contact points 23, 24 either side of the softer alloy seal member 21. At the same time the softer alloy is pressed against the casing and conforms to the casing surface forming a metal-to-metal pressure seal. When subjected to differential pressure the high strength alloy seal support



20 operates as an ideal back-up preventing the softer alloy seal member 21 being extruded between it and the casing surface.

The materials chosen for the seal support 20 are preferably very strong 20, such as titanium, yet can be removed by selective chemical solvents. Titanium has no resistance to hydrofluoric acid, so this may be circulated past the releasable grip arrangement and other components to allow the easy removal of the assembly, alleviating the difficulties of removing an interference fit metal-to-metal seal.

Referring to figure 5, this shows a longitudinal section through the tool which is used to hydraulically engage an releasable grip arrangement according to the invention as a coiled tubing connector 30. The coiled tubing connector 30 grips on the external surface of the coiled tubing 31 using locking members 32, 33 as described above. The coiled tubing connector also includes seal member 34.

Both the seal member 34 and locking members 32, 33 will be put together using an hydraulic assembly system. This consists of a sleeve 35 which can be slide over the external surface of the connector 30. A split sleeve 36 is arranged against the upper surface of the connector 30 by means of support shoulder 38 and connected to the sleeve 35 via two pins 37. This now allows the assembly to be hydraulically pulled together when hydraulic pressure is applied to the chamber 39. Once engaged the outer sleeve of the connector 30 is tight to the threads 40 via access to it by the window 41 of the sleeve 35. This ensures a known force is applied to the metal-to-metal seal 34 ensuring that it conforms to the surface of the coiled tubing 31 with which it is sealing. Similarly, the locking members 32, 33 will be accurately loaded to a known gripping force which can be

engineered to be within the limits of the material it is attached to while being able to withstand the forces acting on it when it is in the well.

This hydraulic energising system also operates on the running tools which will deploy the hangers and packers.

Referring to figure 6 the releasable grip arrangement 1 includes a sleeve 4 which comprises holes 51 which permit the access of the solvent to the seal member 2 or the locking member 3 to dissolve said seal member 2 or locking member 3 or a part thereof. The holes 51 are blocked during normal use of the seal arrangement 1 and may be opened when it is required to break the seal to permit the entrance of the solvent. The holes 51 may be blocked and opened by means of a sliding member. Alternatively the holes 51 may be blocked by resilient caps which can be removed by a suitable mechanical levering action when the holes are required to be opened. In the embodiment in figure 6 the holes 51 are blocked by plugs 52 which may be pushed through when the holes are required to be opened or dissolved.

Figure 7 shows the seal arrangement after the solvent has been applied. The components which were made from dissolvable materials, in this case the seal members 2 and the locking members 4, 4', have been dissolved breaking the seal and permitting the removal or further work on the hanging tubing 51.

A retrieval tool, not shown, would locate in the profile 53 of the hangers main body 54. Hydrofluoric acid would be circulated past the plugs 52, which are metal-to-metal sealing plugs made from a

suitably soluble material such as Titanium. Once the hydrofluoric acid is able to access the exterior surface of the hanger body 54 all the other items dissolvable in hydrofluoric acid will disappear allowing the safe and easy removal of the packer, hanger or connector.

Referring to figures 8 and 9 the grip arrangement 1 for a connector includes a release element 61 which during the normal functioning of the grip arrangement 1 ensures that the it is locked gripping the two tubes 63, 64 together. The release element 61 is made of a dissolvable material such as titanium and which when the appropriate solvent such as hydrofluoric acid is applied it dissolves and permits the release of the grip arrangement 1. Titanium provides the required strength as well as being selectively dissolved when required by an appropriate solvent.

In the grip arrangement shown in figures 8 and 9 the tubular section 63 comprises axially extending slots 62 arranged radially and extending from one end and a protuberance 66 extending radially outwards from said end for engaging with a correspondingly shaped radial 67 groove in the second tubular section 64 such that when the tubes 63, 64 are engaged telescopically together the protuberance 66 engages in the groove 67. The slots permit the inward deformation of the end which permits the protuberance 66 to be disengaged from the groove 67.

The release element is a sleeve 61 is provided arranged concentrically with and internally of the end of the tubular section 63 and preventing internal radial deformation of the end 68 and thus preventing the axial separation of the tubular sections 63, 64. When

the solvent is applied the sleeve 61 is dissolved permitting the inward radial deformation of the end 68 of the tubular section 63 and the consequent release of the tubular sections 63, 64.

Referring to figures 10 and 11 a grip arrangement is shown which acts as a connector between the tubular sections 63, 64 and which is also arranged concentrically with a second grip arrangement for a seal, or a packer 70. A sleeve 71 is provided arranged concentrically with and externally of the end 68 of the tubular section 63 and is made of a material which is dissolvable with an appropriate solvent. When the solvent is applied it passes through the slots 62 of the end 68 of the first tubular section 63 and permits the consequent release of the first and second tubular sections 63, 64. The solvent can then continue to pass through the slots and in between the two released ends of the tubular sections 63, 64 to the second grip arrangement 70. This second grip arrangement 70 comprises further grip parts 72, 73 or seal members 74 at least part of which are made of a material which is dissolvable by the solvent said solvent to release this seal or packer.

## **CLAIMS**

- 1. A releasable grip arrangement 1, for use in an oil or gas well, which is to provide a gripping engagement between a first tubular section 11, 63 and a second tubular section 12, 64; the dissolvable grip arrangement comprising said first and second tubular sections, a first grip part 3 and a second grip part 4 which when engaged together form the required gripping engagement between said first tubular section and said second tubular section, characterised in that at least part of at least one of said first and second grip parts 3, 4 is made of a material which may be dissolved by a suitable solvent.**
- 2. An annular seal arrangement 1 according to claim 1, characterised in that it provides an impermeable barrier in an annular space such as between an inside tube and an outside tube of an oil well, such that a differential pressure can be maintained between one side of the releasable grip arrangement 1 and the other in the longitudinal direction, characterised in that the annular seal arrangement 1 or a part of it is made of a material which may be dissolved by a suitable solvent.**
- 3. An annular seal arrangement 1 according to claim 2, characterised in that it includes at least one seal member 2.**
- 4. An annular seal arrangement 1 according to claim 3, characterised in that the seal member 2 is made from a material which is dissolvable by the solvent.**

5. An releasable grip arrangement according to claim 1, characterised in that the first grip part 3 and the grip part 4 comprise a co-operating ramped thread means 5.

6. An releasable grip arrangement 1 according to claim 1, characterised in that the entire grip arrangement 1 is made from a material which is dissolvable by the solvent.

7. An releasable grip arrangement 1 according to claim 6, characterised in that the material is magnesium.

8. An releasable grip arrangement 1, according to claim 1, characterised in that it includes a sleeve 4 which comprises holes 52 which permit the access of the solvent to the grip parts 3, 4 to dissolve said grips parts 3, 4 or a part thereof.

9. An releasable grip arrangement 1 according to claim 8, characterised in that the holes 52 are blocked during normal use of the grip arrangement 1 and may be opened when it is required to release the grip to permit the entrance of the solvent.

10. An releasable grip arrangement 1 according to claim 9, characterised in that the holes 52 may be blocked and opened by means of a sliding member.

11. An releasable grip arrangement 1 according to claim 9, characterised in that the holes 52 are blocked by resilient caps which can be removed by a suitable mechanical levering action when the holes are required to be opened.

12. An releasable grip arrangement according to claim 9, characterised in that the holes 52 are blocked by plugs which may be pushed through when the holes are required to be opened.

13. An annular seal arrangement 1 according to claim 3, characterised in that the seal member 2 includes a seal support 20.

14. An annular seal arrangement 1 according to claim 13, characterised in that the seal support 20 is made from a material which is dissolvable by a solvent.

15. A releasable grip arrangement 1, according to claim 1, characterised in that it includes a release element 61 which, during the normal functioning of the grip arrangement 1 in the engaged condition, ensures that the grip arrangement 1 is locked against the first and second tubular sections 63, 64 and which when dissolved by the solvent permits the release of the grip arrangement 1.

16. A releasable grip arrangement 1, according to claim 1, characterised in that the first tubular section 63 comprises axially extending slots 62 extending from one end and a protuberance 66 extending radially outwards from said end 68 for engaging with a correspondingly shaped radial 67 groove in the second tubular section 64 such that when the first and second tubes 63, 64 are engaged telescopically together the protuberance 66 engages in the groove 67.

17. A releasable grip arrangement according to claim 16, characterised in that a sleeve 61 is arranged concentrically with and internally of the end of said first tubular section 63 and preventing

internal radial deformation of the end 68 and thus preventing the axial separation of the first and second tubular sections 63, 64.

18. A grip arrangement according to claim 17, characterised in that the sleeve 61 is made of a material which is dissolvable with an appropriate solvent such that when the solvent is applied the sleeve 61 is dissolved permitting the inward radial deformation of the end 68 of the first tubular section 63 and the consequent release of the first and second tubular sections 63, 64.

19. A grip arrangement according to claim 16, characterised in that a sleeve 71 is provided arranged concentrically with and externally of the end 68 of said first tubular section 63.

20. A grip arrangement according to claim 19, characterised in that the sleeve 71 is made of a material which is dissolvable with an appropriate solvent such that when the solvent is applied it passes through the slots 62 of the end 68 of the first tubular section 63 and permits the consequent release of the first and second tubular sections 63, 64.

21. A grip arrangement according to claim 16, characterised in that further grip parts 72, 73 or seal members 74 are provided externally of said second tubular section at least part of which are made of a material which is dissolvable by an appropriate solvent said solvent passing through the slots 62 in the end 68 of the first tubular means 63.



22. An releasable grip arrangement 1, according to and one of claims claim 15 to 21, characterised in that the sleeve 61 is made out of titanium.